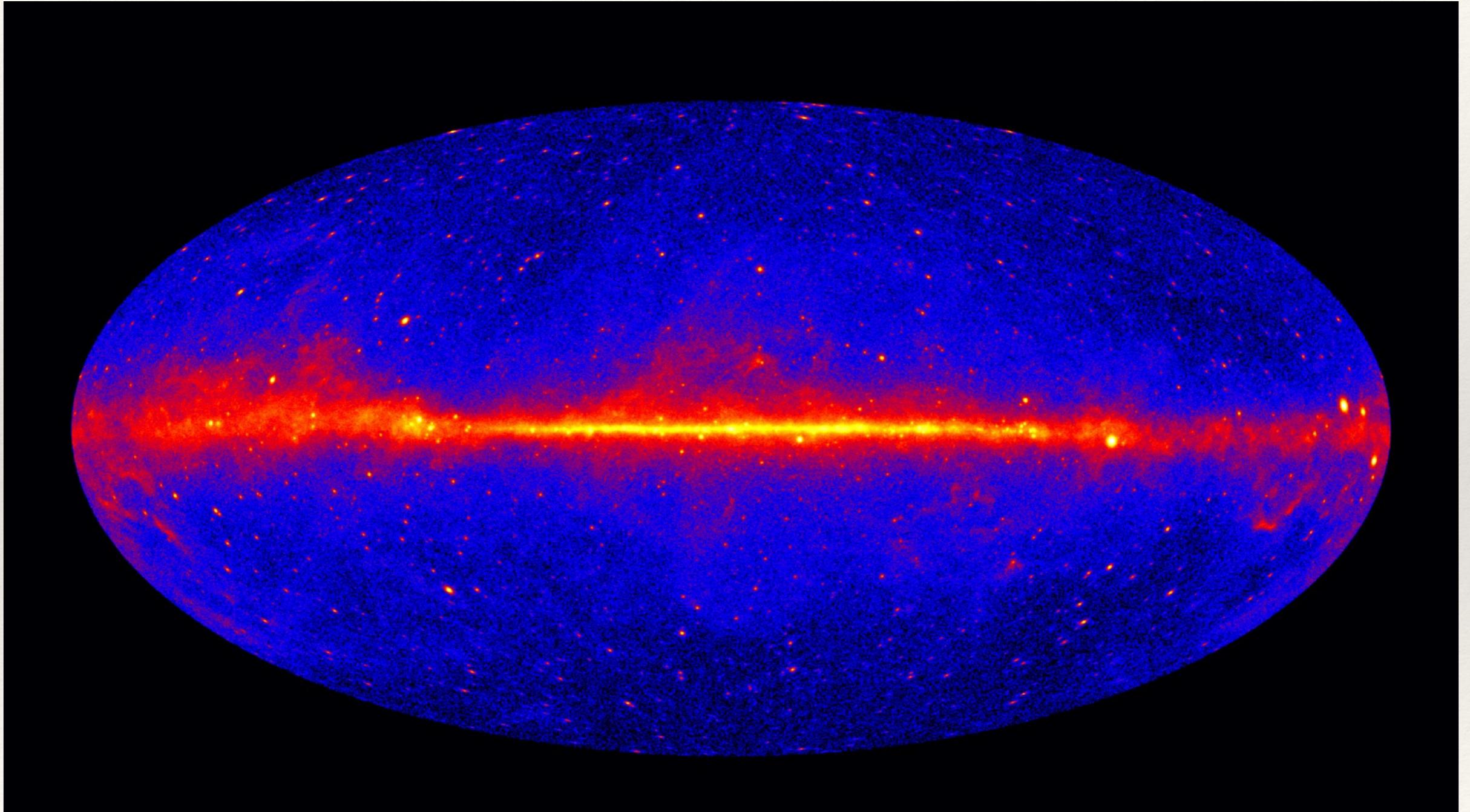


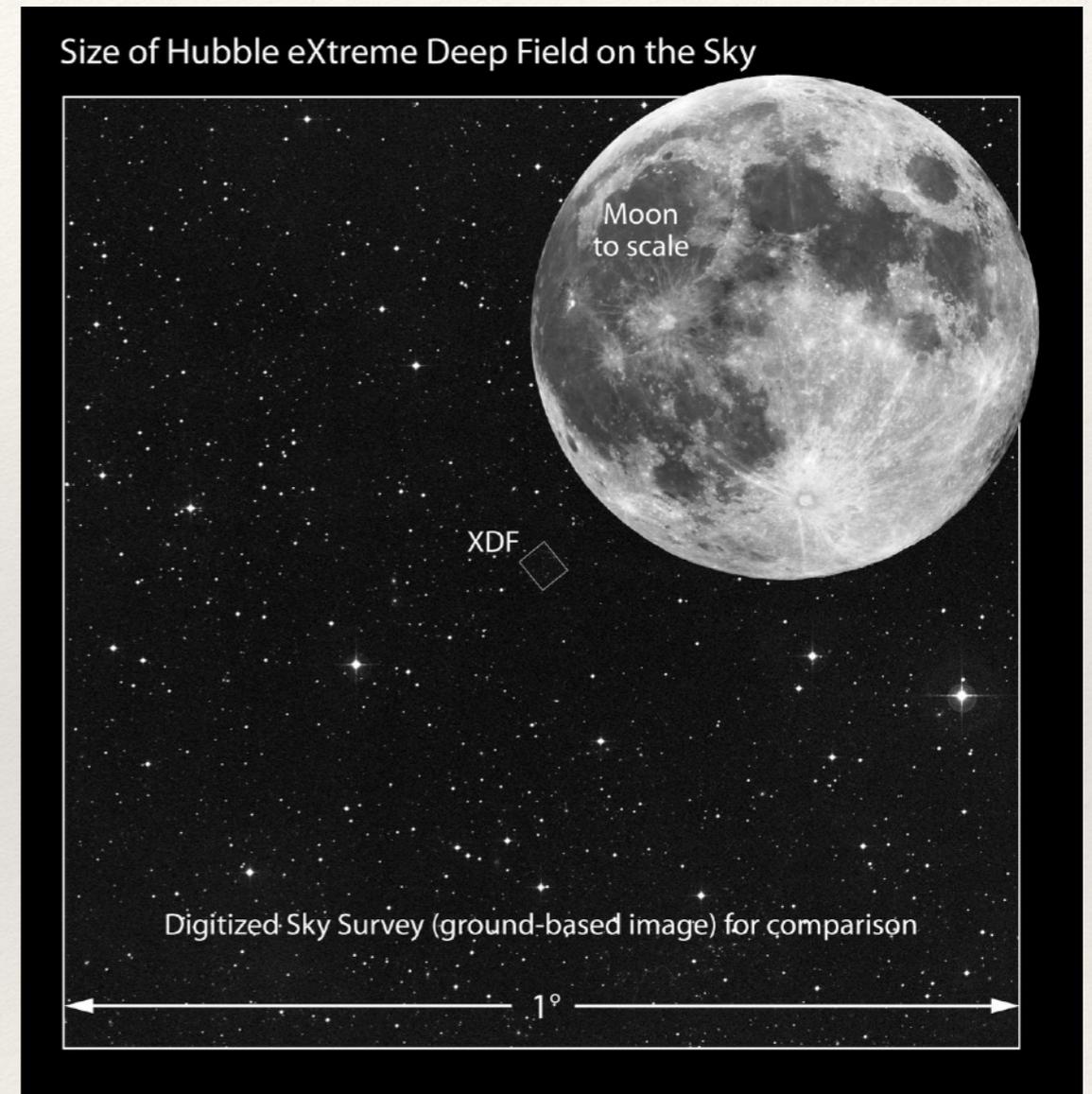
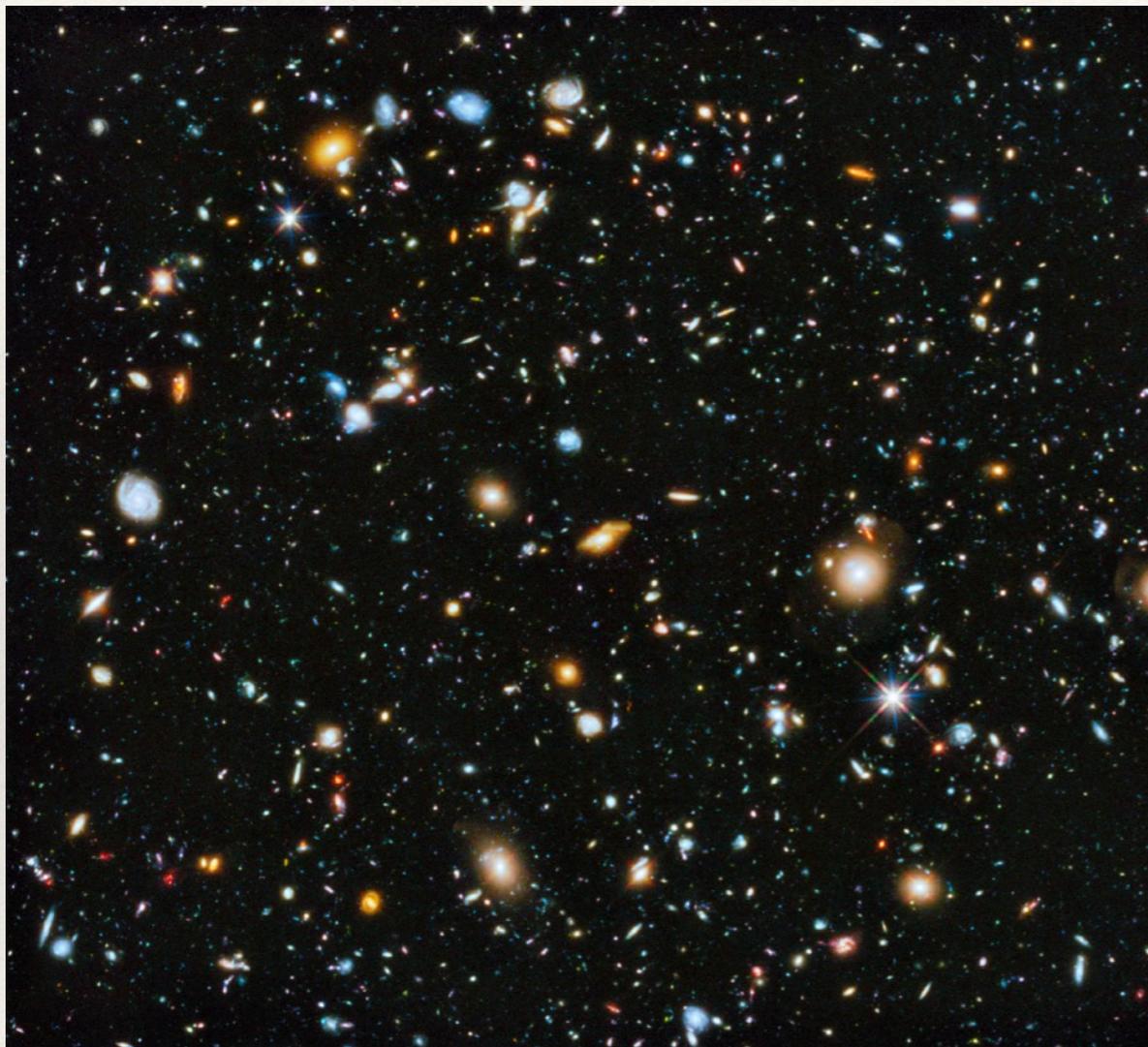
Optical Surveys

Brad Cenko
NASA GSFC
19 October 2018
(Special thanks to Melissa Graham)

Fermi's Most Iconic Image



Most Iconic Optical Image



1 / 13,000,000 of the sky. 50 days to complete -> 178,000 years for all-sky XDF!

All-Sky Automated Survey for Supernovae (ASAS-SN)

- ❖ Groups of 4 co-mounted 14 cm telescopes at 5 (soon to be 6) sites around the globe
- ❖ Imaging in single filter (V/g) nightly to limiting magnitude ~ 17
- ❖ Discovering majority of bright supernovae and many other transients (TDEs, CVs, ...)
- ❖ V $\sim 9-17$ mag: \sim daily observations for several years

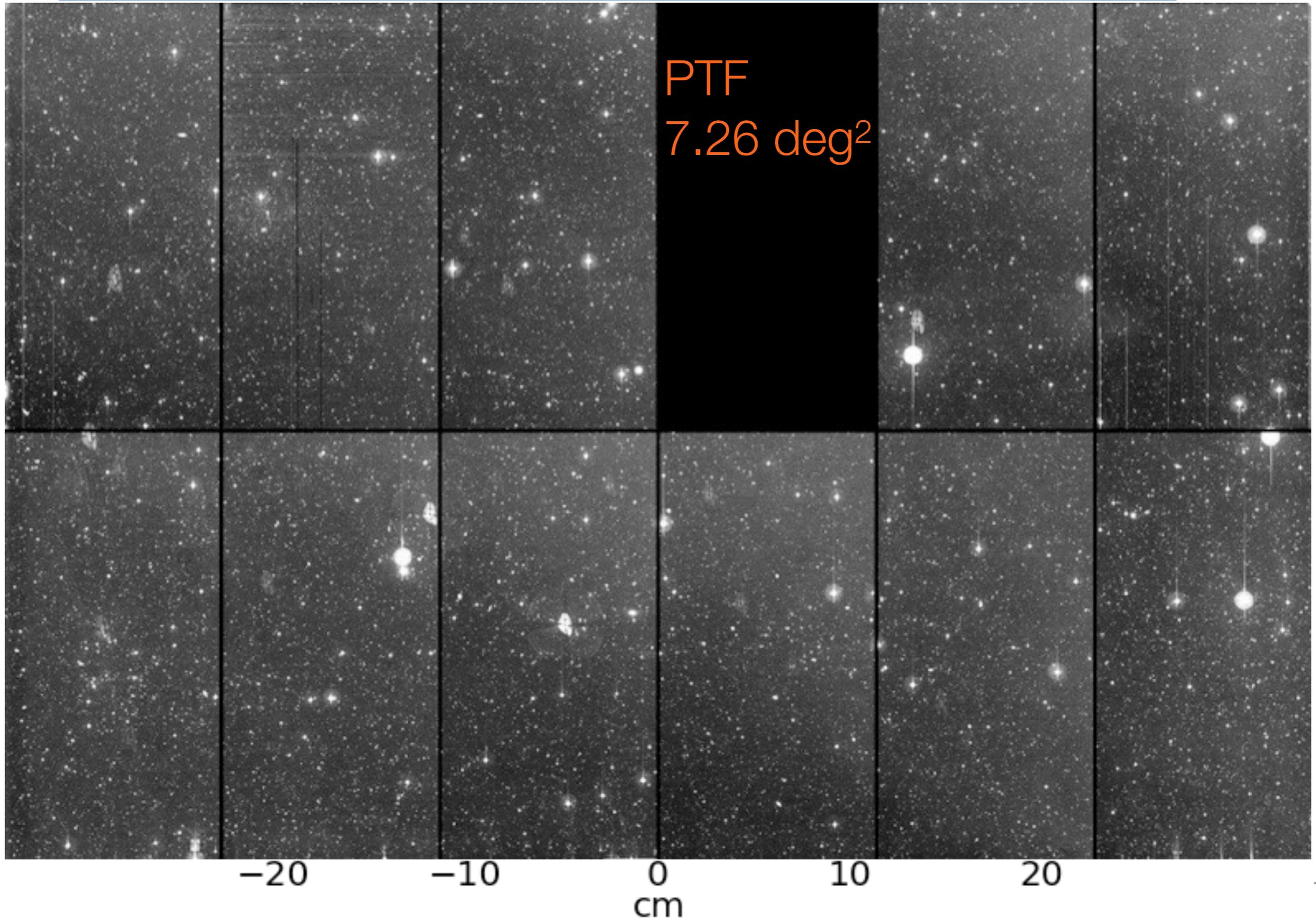


Zwicky Transient Facility

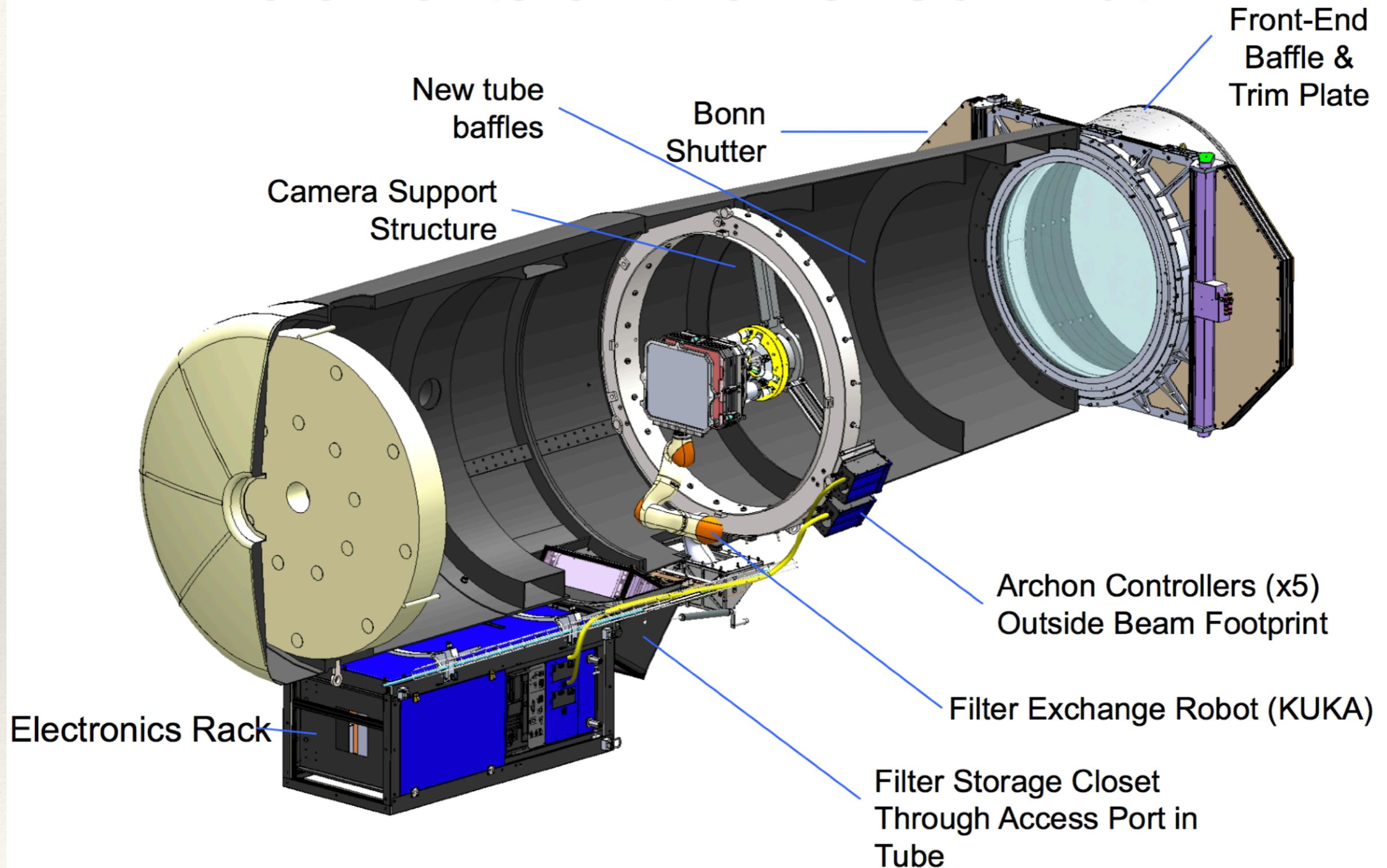


Discovery and follow-up in a single integrated system

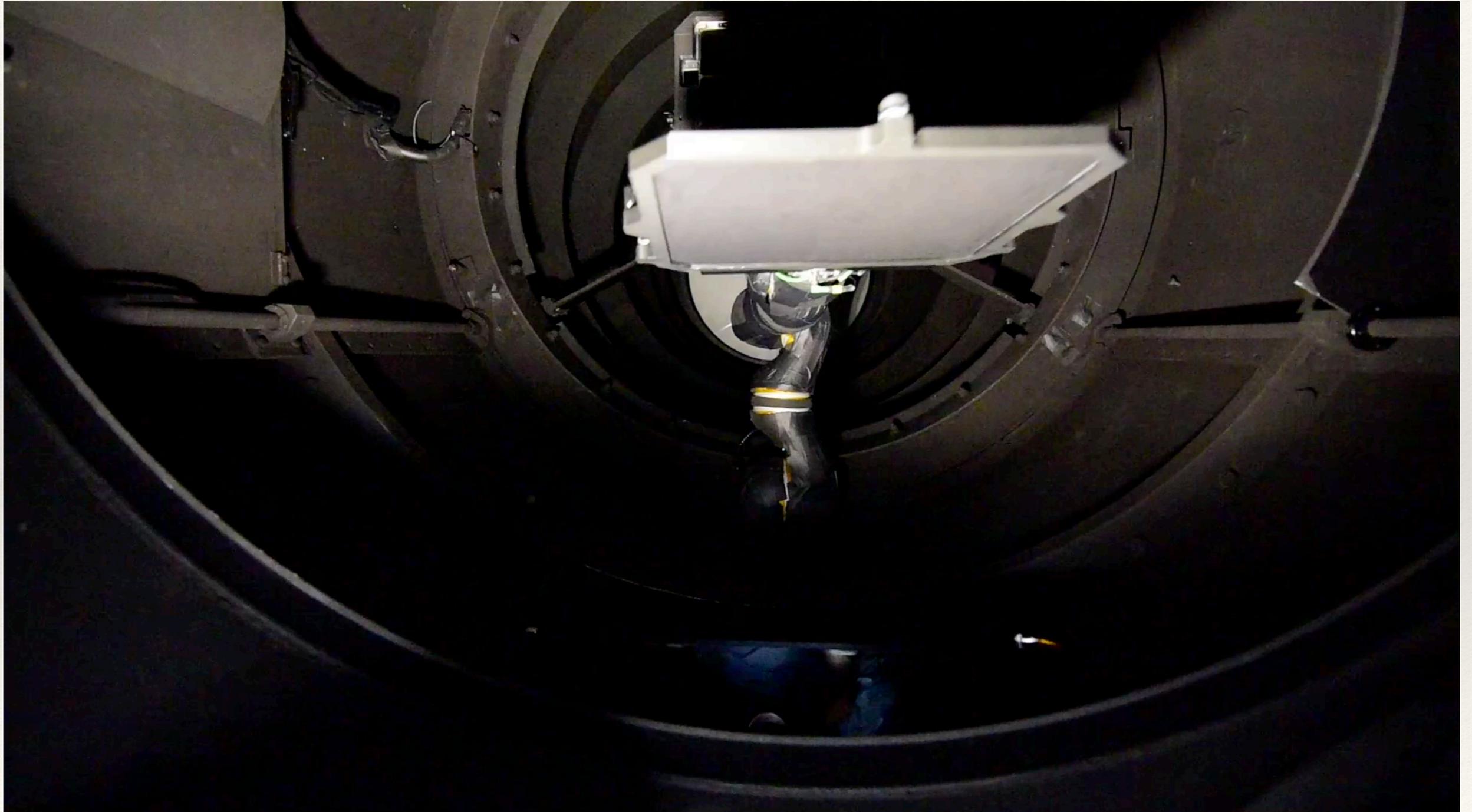
A new camera will fill the P48 focal plane.



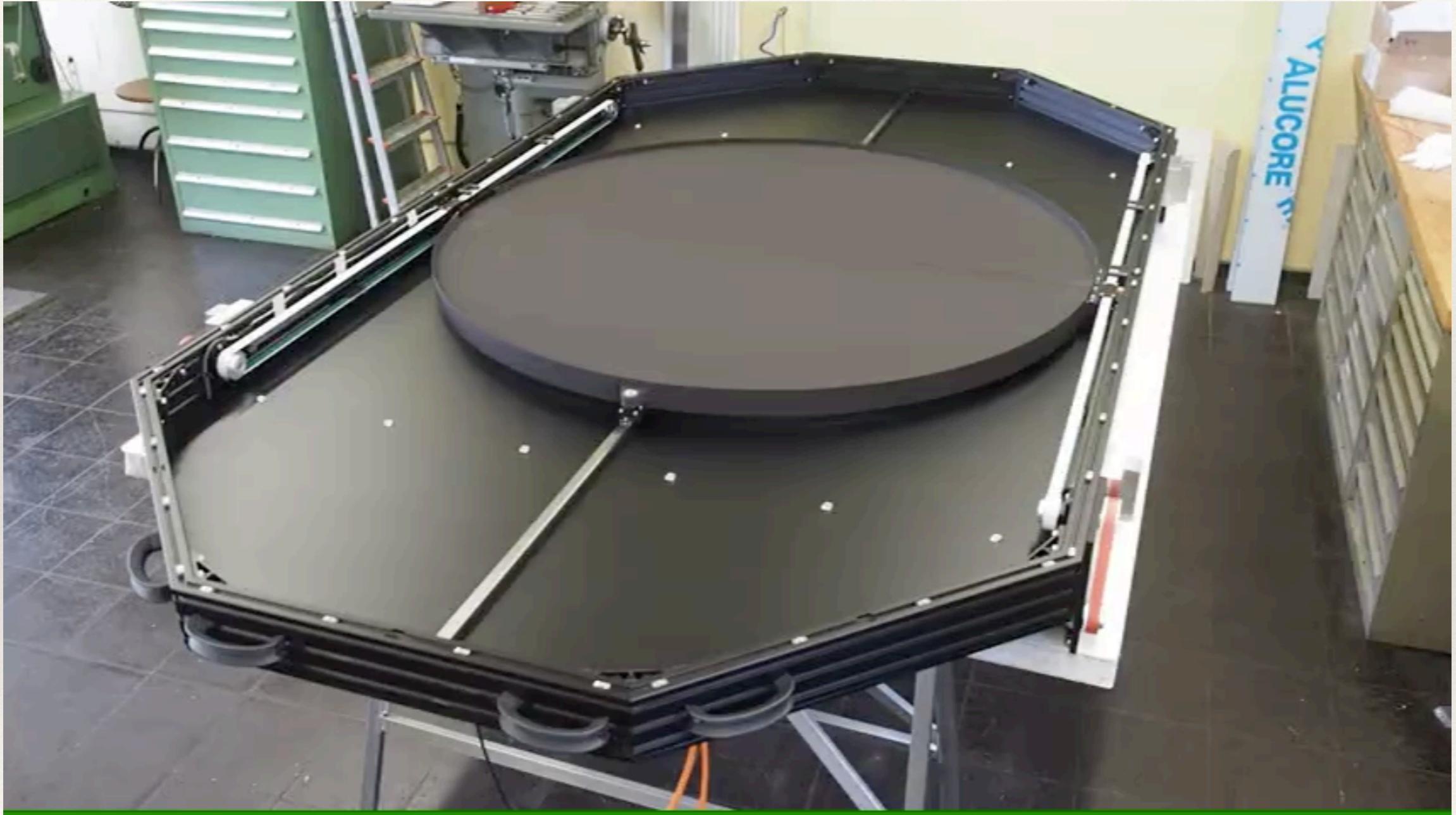
ZTF elements on the 48" Schmidt



Robotic Filter Exchanger



Large Aperture Shutter

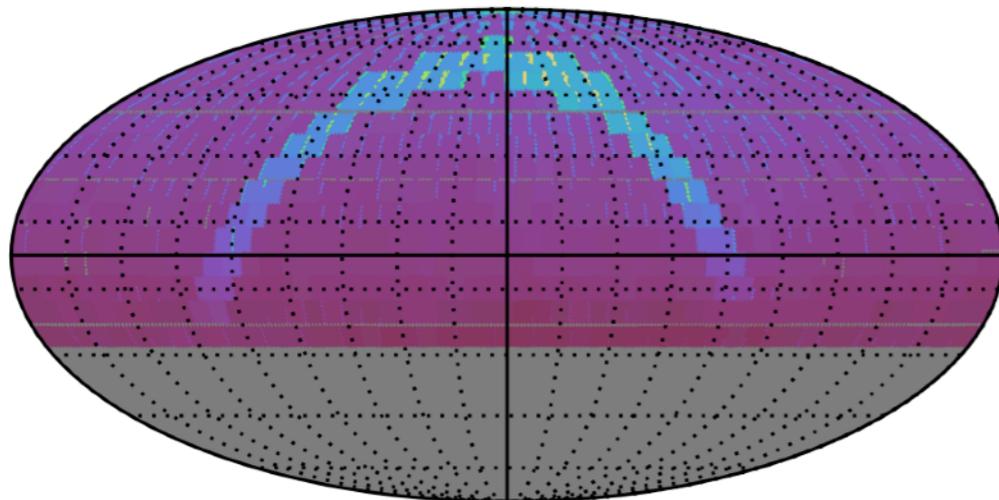


ZTF is a Public-Private Partnership

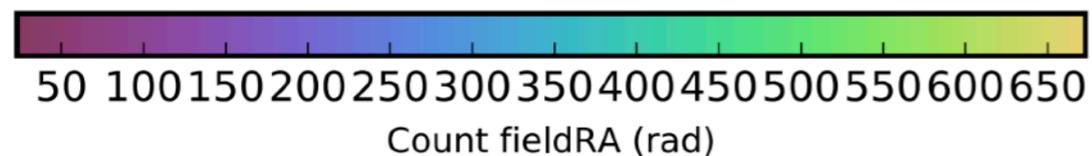
40% of telescope time is for public surveys (NSF MSIP funding)

- 1) Nightly imaging of Galactic Plane (*gr*)
- 2) 3 day cadence survey of entire visible sky (*gr*)

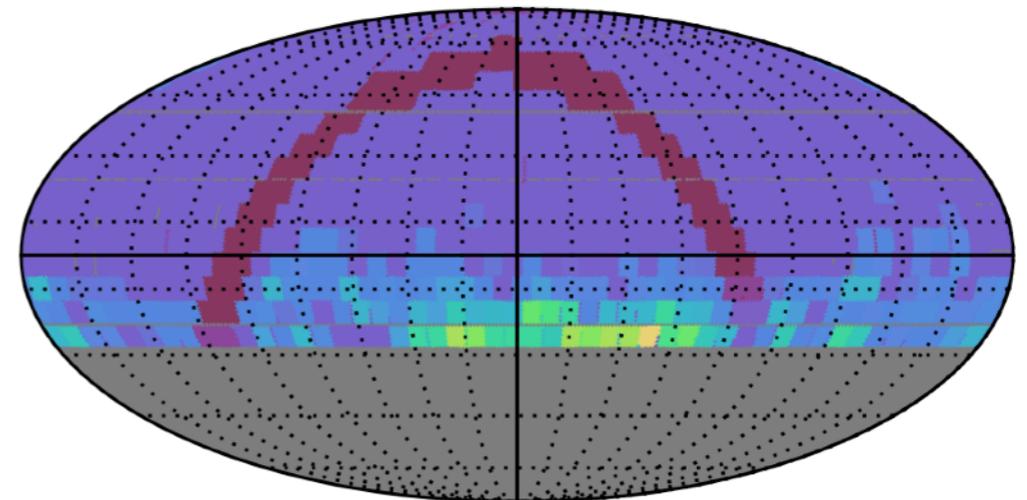
opsim propID 2: Count fieldRA



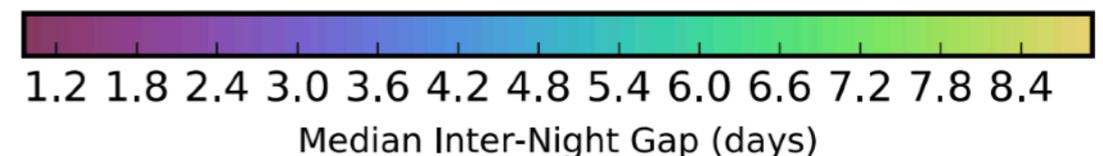
MSIP total observations



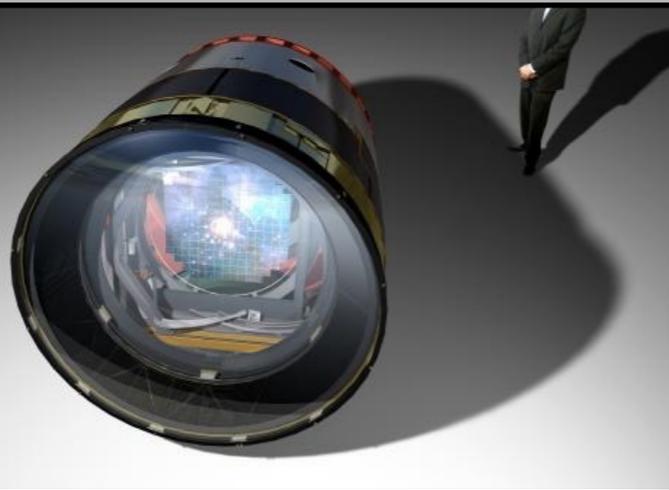
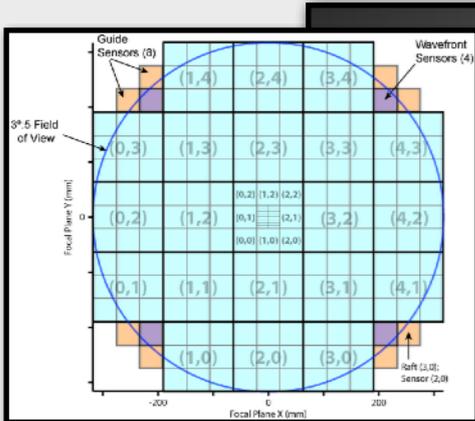
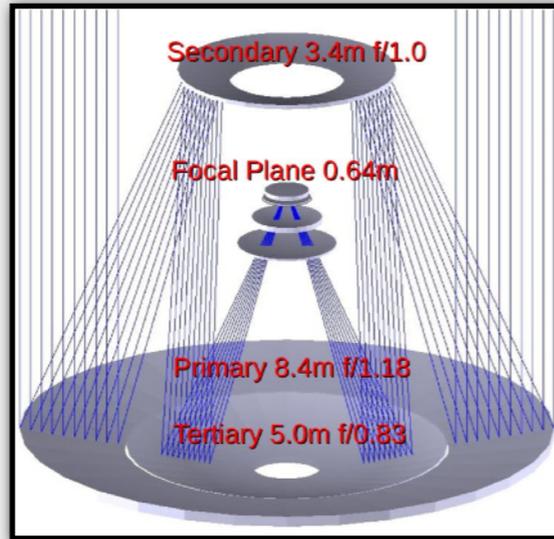
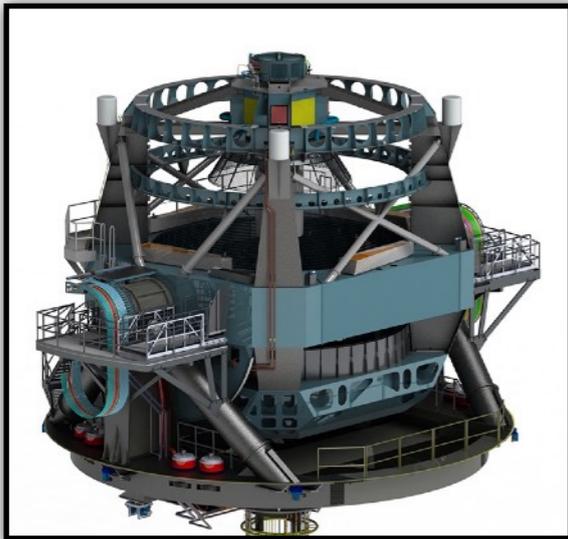
opsim propID 2: Median Inter-Night Gap



MSIP cadence



Transients alerts from public survey available *immediately*



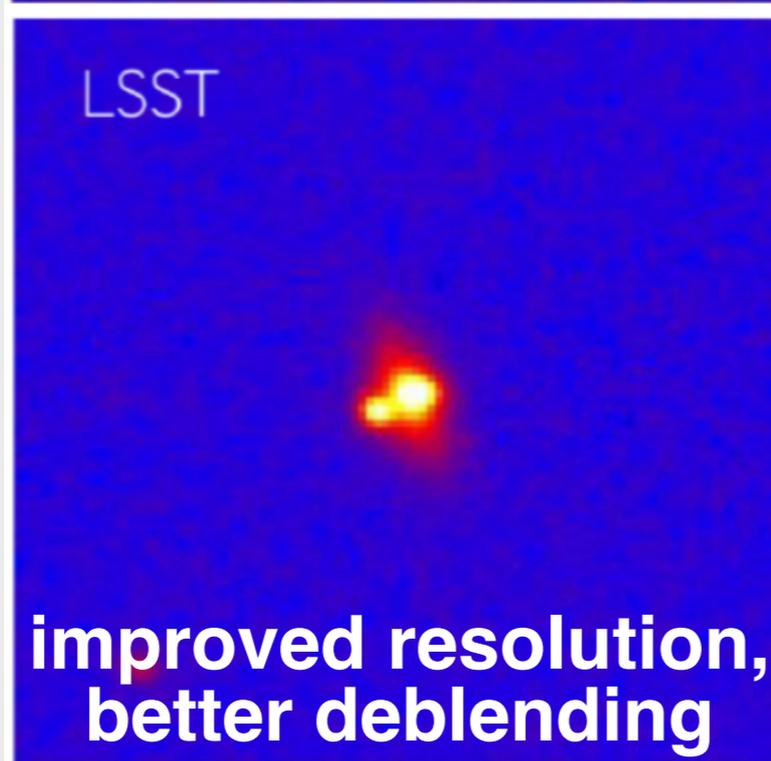
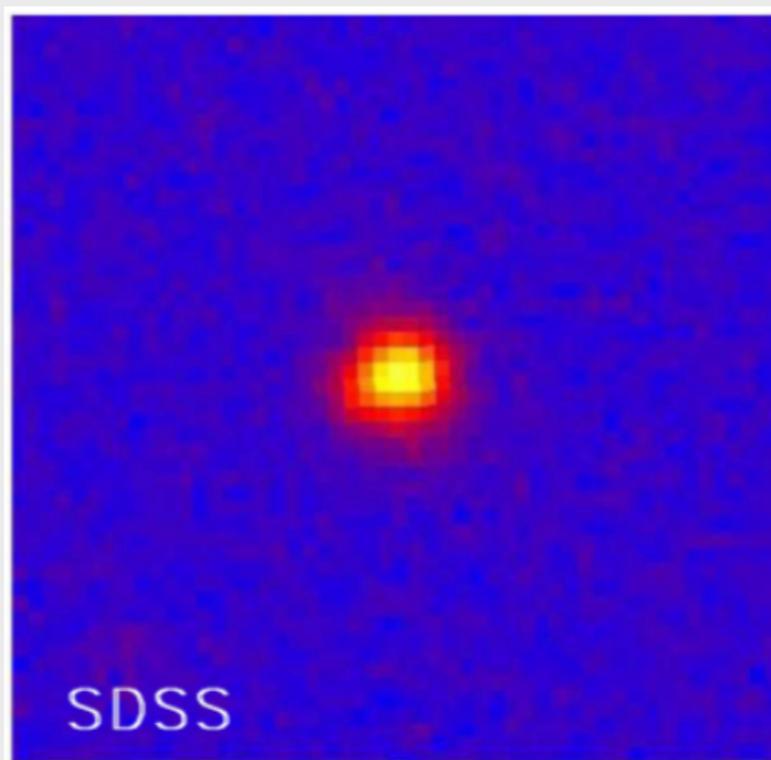
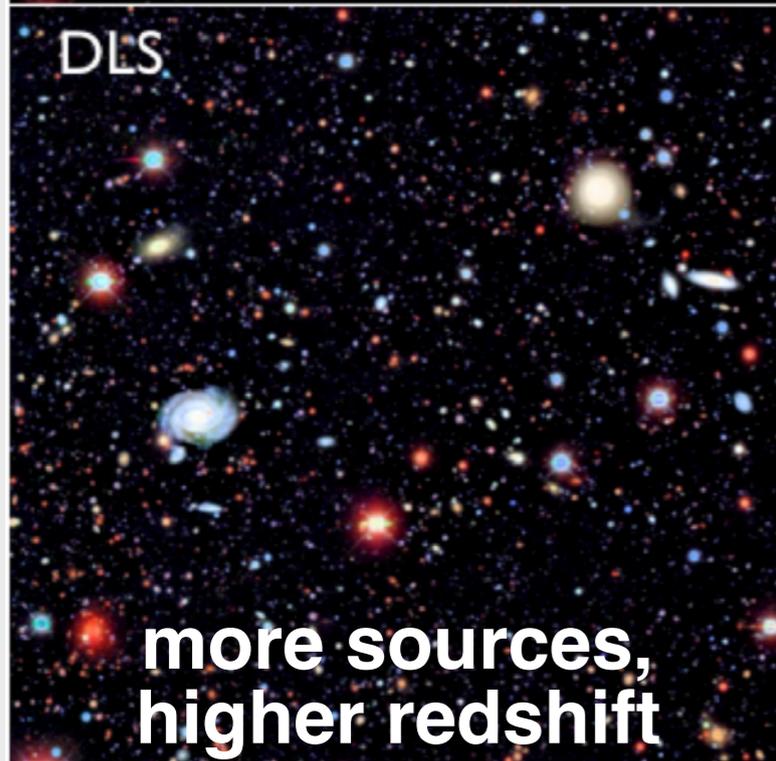
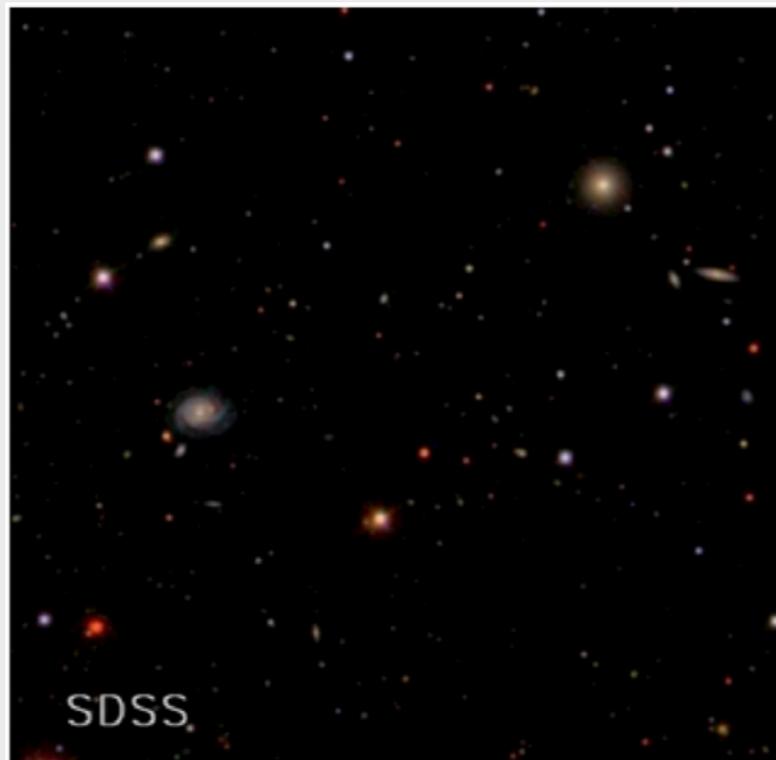
Hardware

primary mirror	8.4 m
field of view	9.6 deg ²
pixel size	10 μm, 0.2"
number of pixels	~3.2 Gpix
filters	<i>u g r i z y</i>

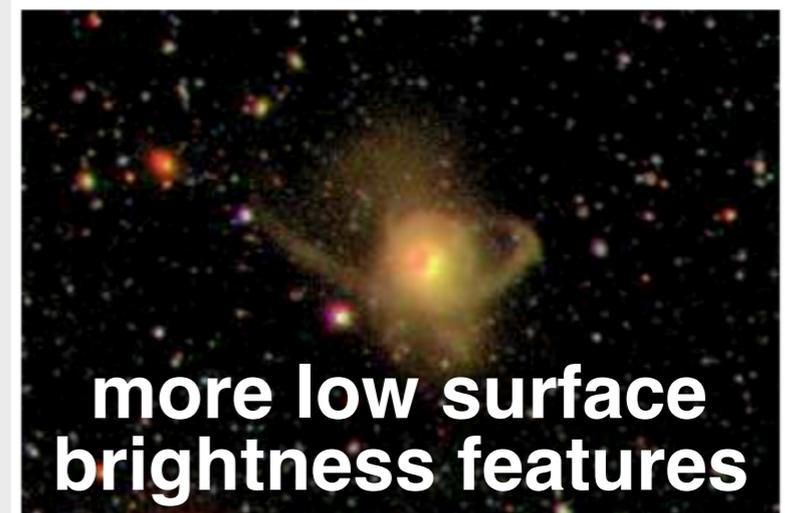
Main Survey (Wide-Fast-Deep)

single-visit exposure	30s (2x15s)
single-visit depth	~ 24, 25, 24.7, 24, 23, 22
single-visit saturation	~ 15, 16, 16, 16, 15, 14
survey visits/field	56,80,184,184,160,160 (824)
survey full depth	~ 26, 27, 27.5, 27, 26, 25
survey full area	18000 ^{o2}
first light	2020
survey start	2022

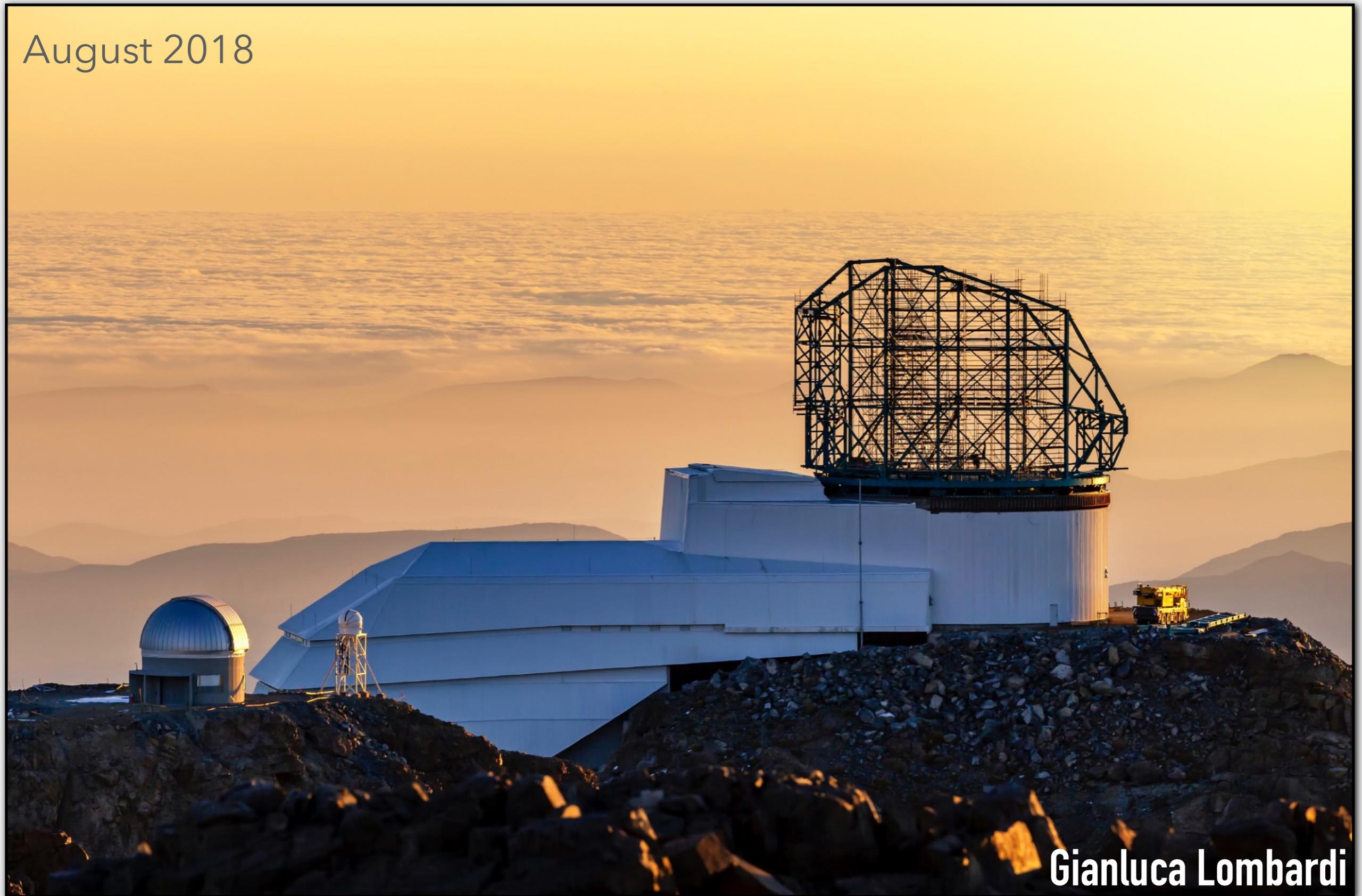
“From Science Drivers to Reference Design”, Ivezić et al. (2008), arXiv:0805.2366



Nightly alerts on ~10 million time-domain events, and final catalogs of ~32 trillion observations of ~40 billion objects over 10 years.



August 2018



Gianluca Lombardi

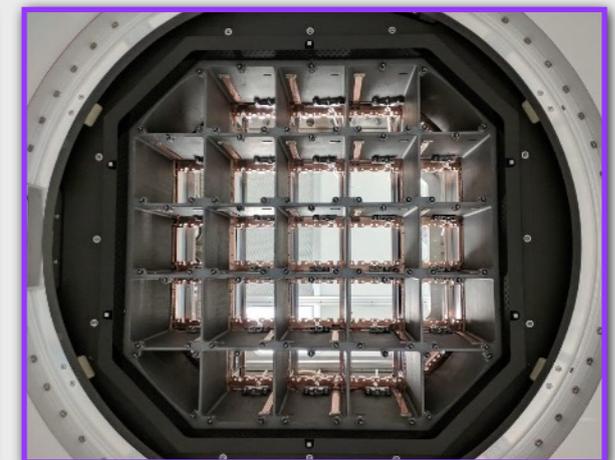
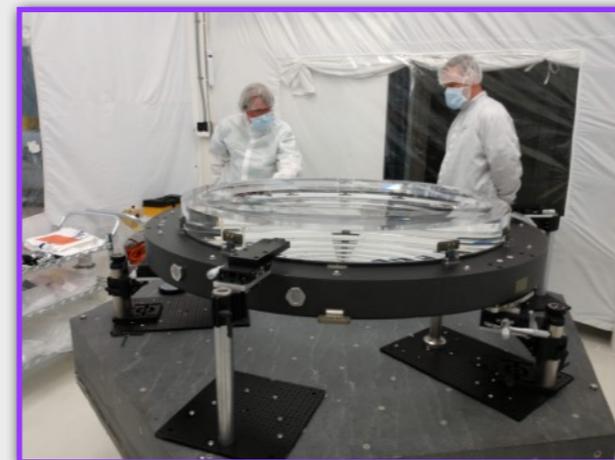
Hardware and Software Highlights in 2018

- La Serena base facility expected completion in 2019
- optical fiber runs to summit; path completed
- Cerro Pachon **summit facility** receiving shipments
- auxiliary telescope is being installed
- mirror coating chamber has been delivered to Chile
- **telescope mount assembly** slews; testing in Spain
- almost all camera sensors have been delivered
- **camera** raft assembly: 1.6 out of 3.2 GP installed (50%)
- camera integration and testing in progress
- **Data Management** (DM) has early version of Science Platform
- DM testing pipelines by applying to HSC images, ZTF Alerts
- Systems Engineering and DM coordinating on **Commissioning plans**
- EPO continues to prototype and test projects & interfaces



All systems are on track for

- **first light 2019**
- **Commissioning start 2020**
- **full Operations 2022**



What is an LSST Alert Packet?

- formatted text file containing schema and data
- full record of the triggering DIASource* ($|S/N| > 5$)
- entire associated DIAObject or SSOBJECT records
- last 12 months of DIASource records
- matching Object IDs from latest Data Release catalog
- image stamps
 - ↳ at least 6"x6"; difference and template; flux, variance, and mask; includes meta-data such as WCS, zero-point, PSF
- 1 per DIASource; VOEvent packet format (or similar)
- released to Alert Stream within 60s of shutter close

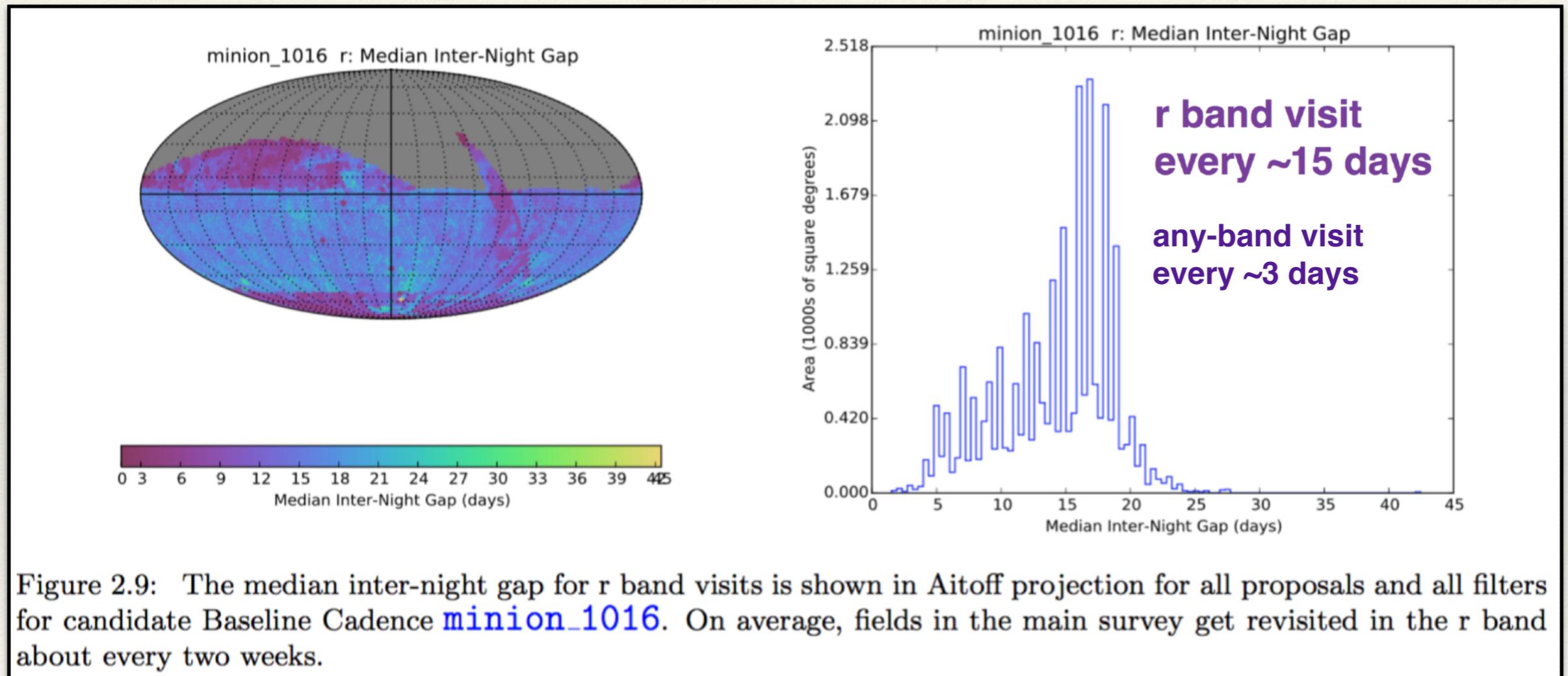
What is a Community Alert Broker?

Software developed independently of LSST to receive, filter, classify, and redistribute alerts; several brokers will be selected by LSST. LSST will provide a basic, limited capacity alert filtering service for astronomers via the Science Platform: "the LSST Mini-Broker".

Examples of Community Alert Brokers Currently Processing ZTF Alerts

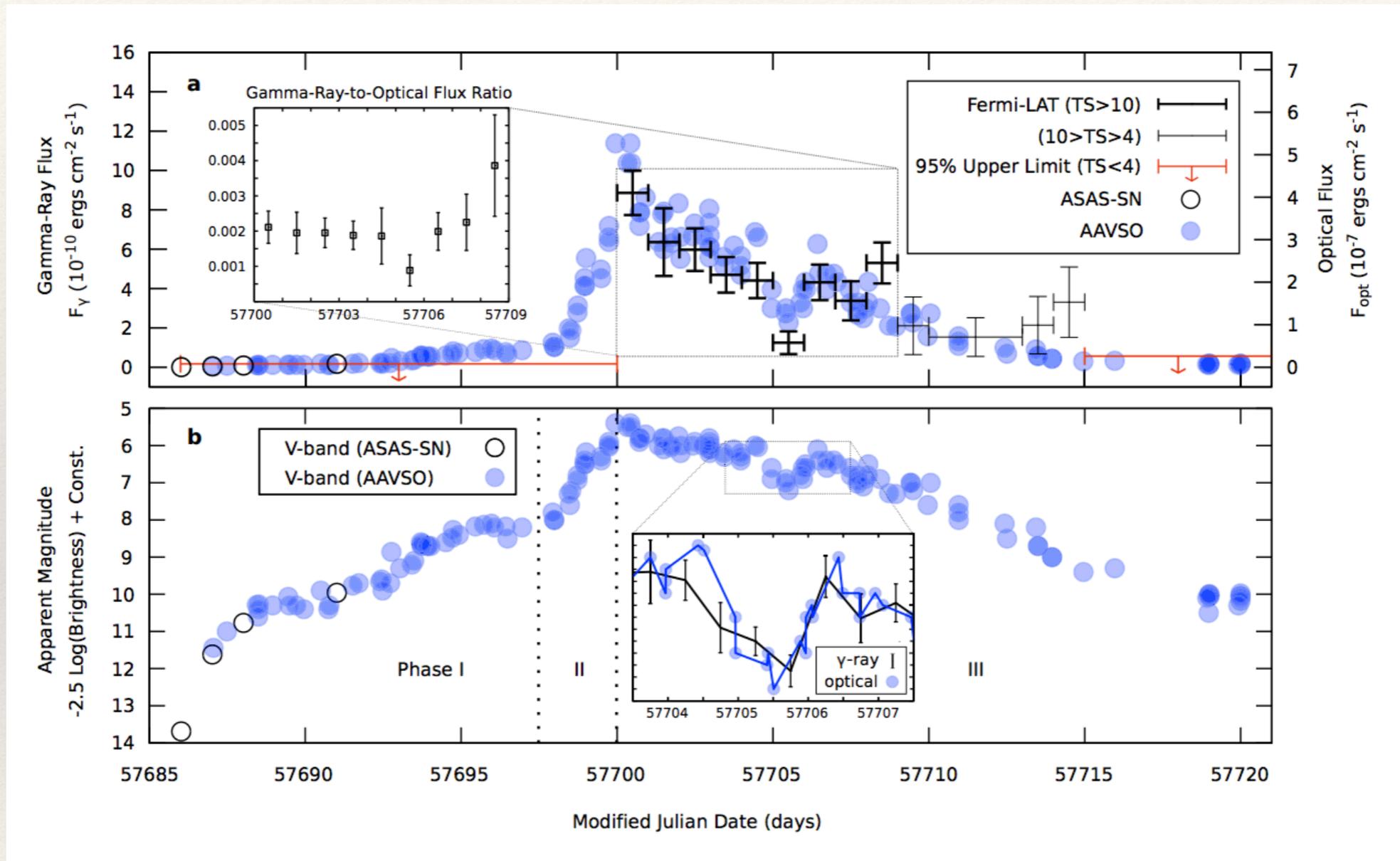


LSST Survey Strategy



Repeat imaging every 3 nights, but in different filters

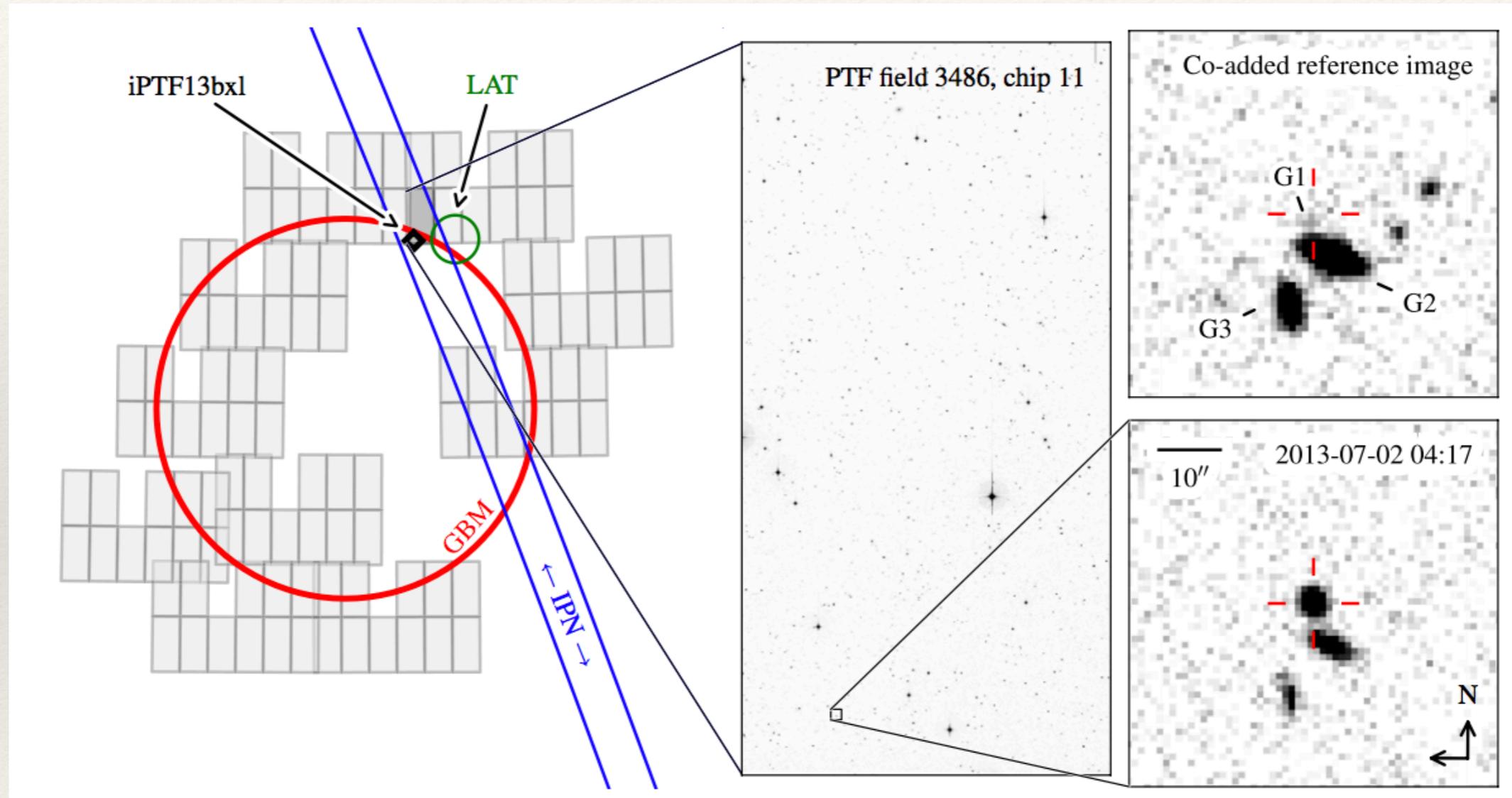
Science Synergies I: Novae



Li+ 2017

Correlated optical and gamma-ray light curves -> optical emission from shocks

Science Synergies II: GRBs

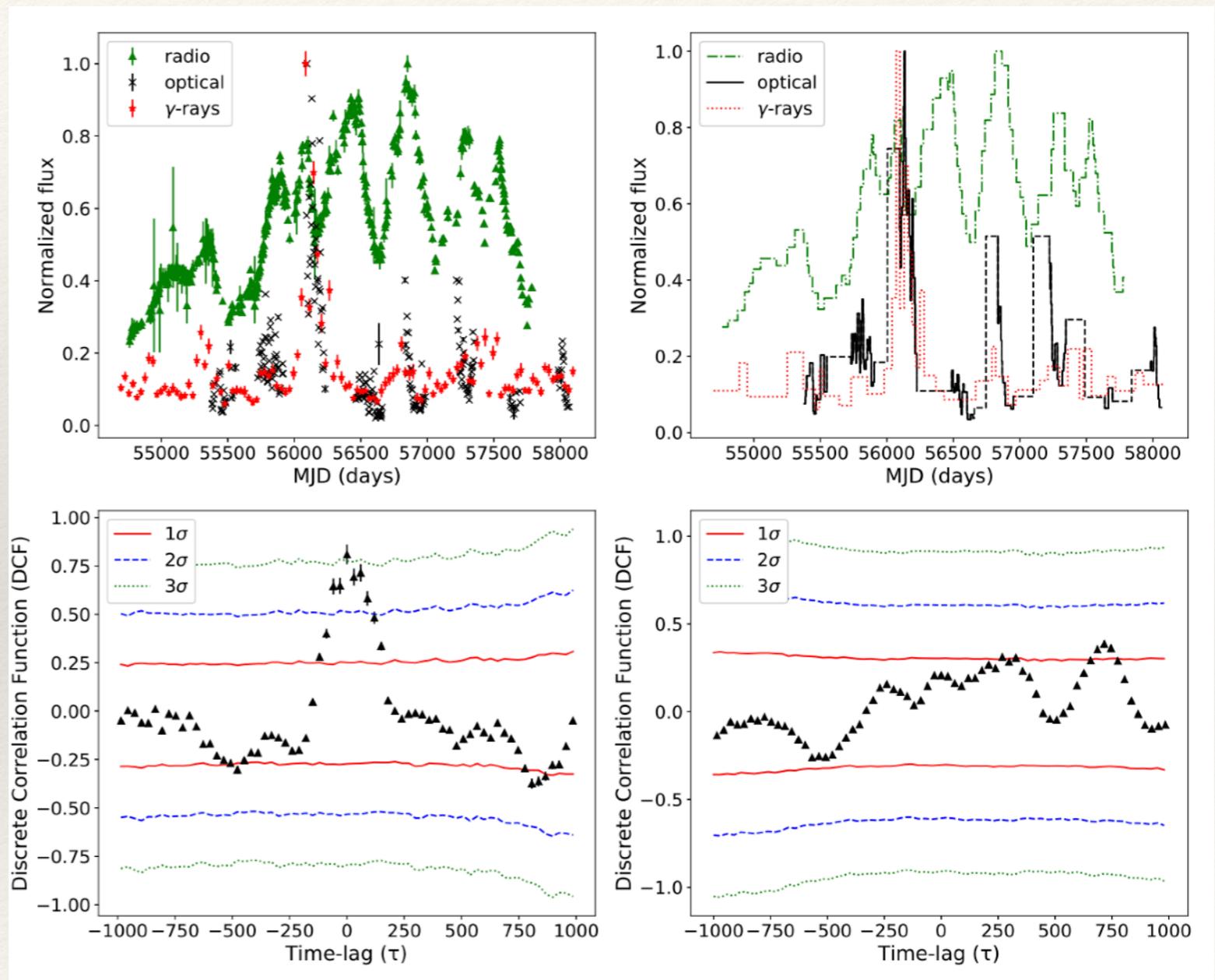


Singer+ 2014

Getting to the point where “follow-up” happens automatically

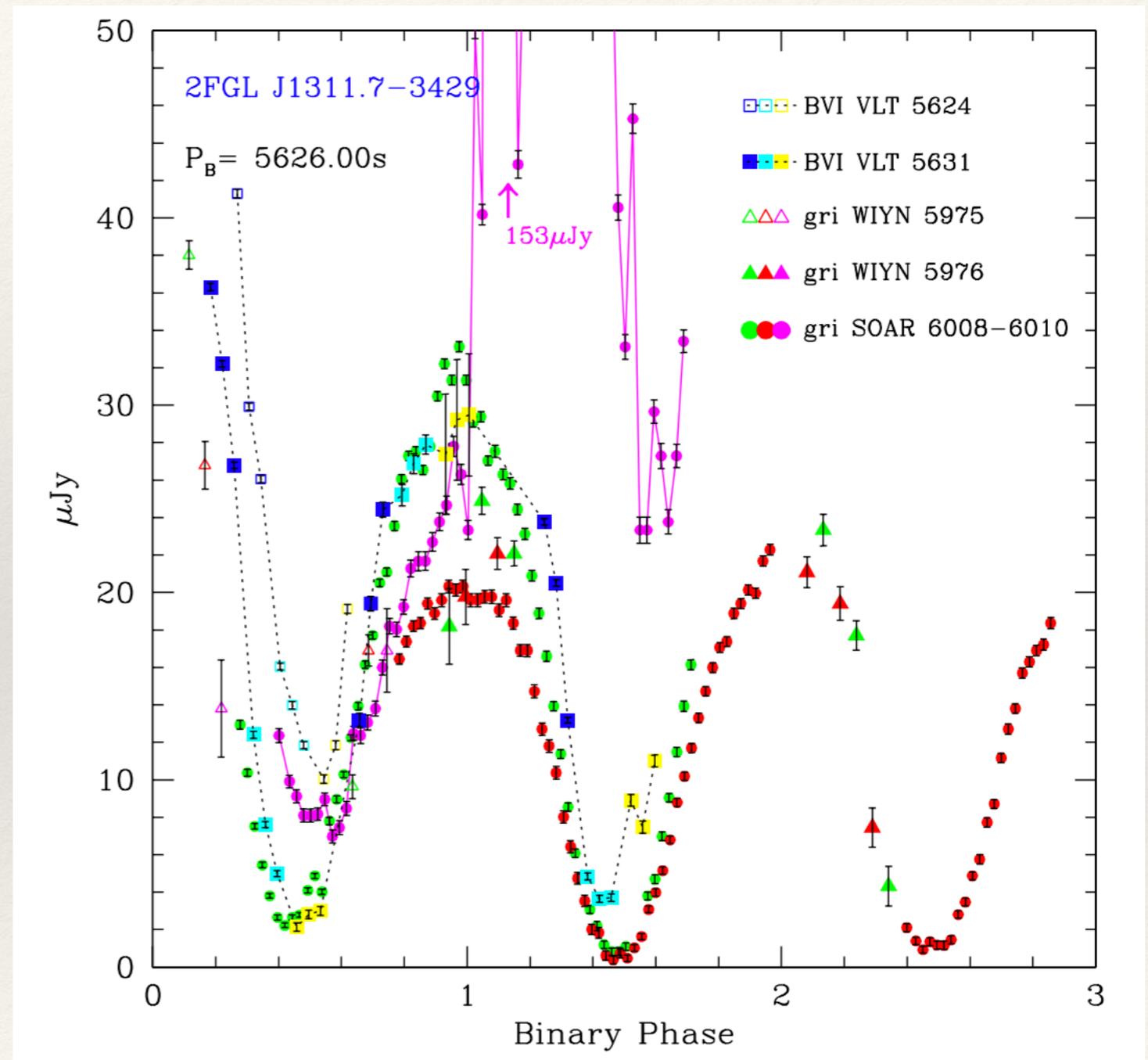
Science Synergies III: Blazars

- ❖ Currently largely done with pointed telescopes
- ❖ Wide-surveys will enable much larger samples to match *Fermi* blazar catalogs



Science Synergies IV: Pulsars

- ❖ Periodicity searches can identify rare “spider” pulsar systems
- ❖ Currently target fields individually, but with LSST can be done *en masse*



Conclusions

- ❖ Broad range of science opportunities for joint analysis with *Fermi* and ground-based optical surveys
- ❖ Impending commissioning of LSST will greatly expand these opportunities